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Leaving the Wild: Lessons from Community Technology Handovers

Nick Taylor¹, Keith Cheverst², Peter Wright¹, Patrick Olivier¹

¹ Culture Lab, School of Computing Science

Newcastle University, UK

{nick.taylor, p.c.wright, patrick.olivier}@ncl.ac.uk

² School of Computing and Communications

Lancaster University, UK

k.cheverst@lancaster.ac.uk

ABSTRACT

As research increasingly turns to work ‘in the wild’ to design and evaluate technologies under real-world conditions, little consideration has been given to what happens when research ends. In many cases, users are heavily involved in the design process and encouraged to integrate the resulting technologies into their lives before they are withdrawn, while in some cases technologies are being left in place after research concludes. Often, little is done to assess the impact and legacy of these deployments. In this paper, we return to two examples in which we designed technologies with the involvement of communities and examine what steps were taken to ensure their long-term viability and what happened following the departure of researchers. From these examples, we provide guidelines for planning and executing technology handovers when conducting research with communities.

Author Keywords

Community; research in the wild; action research; longitudinal.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Research involving the design of novel technologies is increasingly coming to recognise the value of deployments ‘in the wild’ [26], where designs can be trialled and evaluated over long periods of time through actual day-to-day use. HCI research has long held that our interactions with technology are situated within particular “material and social circumstances” [27] and that technologies increasingly “exploit this fact in how they interact with us” [7]. It recognises the importance of trialling new technologies in-situ, where they can be used within the physical and social contexts that determine how they are interpreted. We ask not just how usable systems are or how users respond to them in the short term, but how they can

be designed to integrate into people’s everyday routines and make a meaningful impact on their lives in the long term.

This approach often means not just designing for individual or representative users, but for entire communities and groups. It also implies long-term engagement with these groups of users, so that researchers can gain a deeper understanding of the community and see use of technology evolve over time. This can be seen in projects like the Blacksburg Electronic Village [3], where one community’s use of emerging and evolving technologies was studied for many years. Such research frequently takes an action research [14] approach, identifying real problems in real environments and working iteratively with involvement from the community to design technology interventions, often through long-term engagement with a user group or community. Particular configurations of action research-like approaches have emerged in a number of different contexts to support the design of new technologies with communities [15, 28].

There are clear advantages for both researchers and participants in these more symbiotic and reflexive approaches. However, it also raises questions about the way we do research. If we are designing interventions intended to have some positive impact on the lives of users, what happens at the end of the study? While researchers can leave this process with valuable findings, the technologies designed with the community are often simply taken back to the lab or redeployed with new users, leaving study participants without a technology they may have come to value and that is not available to purchase. In some cases, prototypes have been left in the field permanently, but this raises problems of its own: research prototypes are typically not finished products and their developers are usually not capable of providing long-term technical support, meaning users are very much on their own once a project concludes. Experience in navigating these issues is most often gained through trial and error, as research publications typically focus only on the point up to which active research ceases and do not discuss the final fate of their prototypes, making it difficult for us to learn from the experiences of others.

In this paper, we suggest that greater consideration needs to be given to what happens at the end of research projects and beyond. We revisit two projects where community technologies were designed through close collaboration with participants and intended from the start to be left with

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the community in the long term. In each case, we see problems that arose despite the best intentions of researchers and actions that could have been taken to mitigate these problems during the lifetime of the project and during the technology handover. From these two case studies, we provide a set of guidelines for researchers involved in longer-term deployments, intended to encourage greater consideration of exit strategies and help mitigate some of the issues outlined above.

RESEARCH WITH COMMUNITIES

Whereas much of the research conducted ‘in the wild’ seeks to explore the usability and utility of prototypes in real-world settings [21], a growing subset of this research seeks to examine the use of technologies over long periods of time and understand how they are adopted and integrated into users’ lives. This provides time for a technology to become embedded in the users’ communicative ecology [8], taking into account the variations in use and rhythms of everyday life that can only emerge over time, while also allowing a more experience-centred [19] approach to the design of new technologies.

Initially, this type of research was achieved through living labs [1, 17], in which deployment environments, such as homes or classrooms, were simulated in a lab setting where use could be observed. However, there is now a growing trend of deploying prototypes in *real* homes and workplaces rather than lab-based simulations. This approach brings its own strengths and challenges, and numerous methods have emerged that cater to the needs of long-term, real-world deployments. Technology probes [16], a method we have employed extensively in our own research, involve the deployment of a functional prototype to provide experience with a new technology and inspire design ideas, while at the same time learning about the deployment environment. Likewise, work by Gaver *et al.* [9] has involved intentionally vague technologies that the user is encouraged to experiment with over long periods, allowing purpose and meaning to emerge through this process.

In much of this work, we are taking an *action research* approach, which “focuses on simultaneous action and research in a participative manner” [5]. In this approach, researchers work closely with a community or group of users to address a specific problem with the user group. The goal is to create a *sustainable* change in the target environment through cycles of iteration and observation, while generating knowledge and experience as a research output. This has been identified as a valuable method in relation to new technologies that “involve constant innovation and change; have unpredictable outcomes; and require flexibility, creativity, and an inclusive, user-centred approach” [14].

While this approach has been very successful in working with communities and other user groups, Hayes [12] notes that difficulties can arise when leaving a field site. Whereas

other applications of action research might create, for example, new workplace practices, action research in HCI typically results in the creation of new technologies that can be much more difficult for the community themselves to support after the conclusion of the project. Gurstein [11] discusses issues of sustainability primarily in terms of finances, but we see also see sustainability issues in terms of technical capabilities, community engagement and content creation. Existing literature recommends a focus on this “human and social infrastructure” [13] and the creation of skills within the community to ensure sustainability [20], but this can be difficult when prototype technologies extend beyond those skills that can be reasonably acquired by volunteers. For example, the deeply embedded and situated nature of ubiquitous technologies means they benefit greatly from deployments in the wild [4, 6, 25], but they are also more difficult for participants to maintain.

It should be clear that we have a responsibility to at least consider the sustainability of the technologies we design. We are often asking participants “to integrate a novel technology into their lives in order to change behaviour” [26], presumably to have some positive and meaningful impact in the long term. We build relationships with our participants and engage with communities over periods of months or years. Moreover, participants are often involved in projects as co-designers and co-researchers, implying a considerable amount of effort on their part. Participants may spend many hours in focus groups and design sessions, or put considerable effort into completing probes and diaries. Although participants will typically be briefed about what will be asked of them prior to taking part in a project, their feelings about this might change over a prolonged period of engagement.

Our experience with these approaches has exposed us to both the benefits and potential pitfalls of conducting action research with communities, but we have been particularly drawn to the question of what happens when the research ends. We see the challenges facing handovers of community technologies as falling into three interlinked categories, each of which must be addressed through the process of developing and handing over technologies:

- *Technology* issues arise due to the nature of the deployments. Typically, these are prototypes rather than finished products and research projects rarely, if ever, have the resources to create and test technologies to an extent that rivals commercial products. As a result, even when technologies are handed over to a community, they may face failure with little chance of technical support or replacement.
- *Usage* issues cover the sustainable use and generation of content for the technologies. In many cases, researchers may play a role in seeding content or encouraging generation of content from the user group. In other cases, researchers may simply be responsible for creating enthusiasm around the project. If adequate sustainable

service models are not in place before the end of the project, a technology can be given to the community but might not be used.

- *Resource* issues, both financial and human, underlie both these previous categories. Research funding naturally comes to an end with the project and small community ventures often do not have funding available to support new technologies themselves. Just as importantly, the participants and researchers who have invested time in either developing or using prototype technologies have specific motivations for their involvement, which may change over time, especially when the project comes to a close. Even well-engineered and widely-used prototypes may ultimately fail if not supported by key stakeholders.

In the following sections, we will describe how these challenges manifested themselves in two case studies involving the handover of community technologies. Both these projects involved working closely with communities over long periods of time and involved members of the community in the design process.

CASE STUDY 1: WRAYDISPLAY

The first of our case studies, WrayDisplay [29], was a digital noticeboard developed for Wray, a small village in North West England, between 2006 and 2010. Having previously been used as a test site for a wireless mesh network, which provided broadband Internet to the village for the first time and generated considerable goodwill towards the university, Wray began to act as a test bed for research projects. Across a period of over four years, researchers worked closely with residents, including one ‘champion’ who acted as an access point [18] for the community, to develop a public display that supported the local community. The long-term nature of this project was a key characteristic of the research: we investigated how use of the display emerged over time and how real experience with relevant technologies could help community members to engage in an extended participatory design process.

Over the length of the project, we deployed a series of public display prototypes in the village. This began with the Wray Photo Display, an extremely simple display comprising a touchscreen display powered by a compact PC running a bespoke Java application (Figure 1). This allowed residents to upload their photographs via a website, which could then be seen by other residents on a display in the village shop. This was intended to act as a technology probe to expose the community to relevant technologies. Over time, the display was iteratively developed into WrayDisplay, which displayed photographs, upcoming events and advertisements, all of which were posted by residents themselves. During the final year of the project, the deployment was extended to include a second display installed in a local café. These displays had become integral in residents’ photo sharing behaviours, with residents sharing over 1,500 photos by the end of the project, many of which had never been made public before. The event

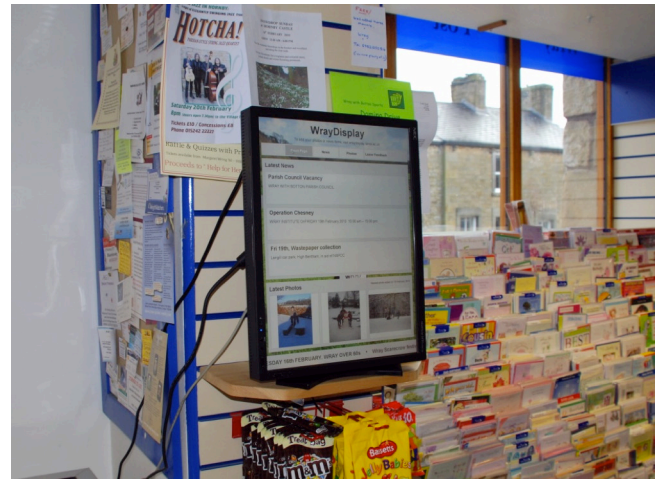


Figure 1. WrayDisplay deployed in the village shop.

listings and advertisements were also able to augment existing methods of sharing this content in the village.

Handover Process

At the start of the project, the participants who provided initial input were told that any hardware deployments could remain in the village, an assurance that was repeated as the project neared its conclusion. This assurance arose from our appreciation of the large contribution made by the community during the study and the way in which the displays had become instrumental in sharing residents’ photos.

During the final round of iterative design, it was made clear that it would be the last set of alterations and that the display could only be provided ‘as is’ without any guarantees. Our champion was assured that technical support would be provided on a voluntary basis to whatever extent was possible, but it was also made clear that this could not be prioritised and might therefore be limited and delayed in practice. This was largely due to the researcher who had developed the display moving to an institution in a different part of the country.

Given the possibility of hardware failures, residents proved to be more concerned about the display’s content than the display itself, particularly the photographs. Despite many of the photos now being available on the Internet, either on popular photo sharing sites or on the village website, they were described as being “all over the place”—the display had brought together disparate sources of community content and one resident noted that recreating this collection would be “a lot of work”. For this reason, our champion was provided with a back-up tool that synchronised the display’s content with her PC. However, the displays still relied on a university web server to host the display’s content and website. This was a trade-off to provide services that are very easy for the university to provide, but which would potentially be expensive and difficult to manage for the community.

Legacy

Perhaps predictably, the first technical problem occurred only a few months after the project's conclusion, when the PC running the shop display suffered a hard drive failure. Fortunately, content was held on a separate server, so the second display continued to function and the content remained accessible via the website and backup tool. Our precautions had centred on the backup tool, with the assumption that there would be no attempt to repair the display, but we had not anticipated that failure would occur so close to the end of the project. As we were still in relatively close communication with the community, our champion contacted us for help, which we provided partly due to a sense of moral obligation. However, there were also more practical considerations: previous groups of researchers had worked in Wray before us to generate relationships and trust that enabled our project, so there was a responsibility to maintain this relationship for the benefit of subsequent projects—not least any of our own—that might wish to work in Wray. In this sense, disengaging from the project proved to be more complex than we had anticipated.

Initially, our champion provided an old laptop to replace the PC, while we provided a package of software and instructions for building a new display. However, although she was technically proficient, the software was not as easy to install as commercial software, due to the configuration required and several dependencies (e.g. a database installation). Eventually, the display was set up through a combination of email support, a site visit by the remote researcher and remote desktop sessions. A new PC was later provided as a goodwill gesture by one of the researchers.

Beyond these technical issues, there was also a noticeable change in usage of the display, seen in the considerable drop in levels of activity after the project concluded. After an initial surge in activity when the first display was deployed, usage held at a steady rate throughout the deployment. As such, we are confident that any novelty effect had been eliminated during the lifetime of the project. However, the drop in contributions after the end of the project was clear: for example, only 173 images were uploaded in 2011, compared to 418 in 2010 and 327 in 2009. Advertisements and events posted to the display have also seen a decline, to the extent that we have often seen these pages devoid of any current content. This drop in activity is particularly problematic for the noticeboard functionality as, unlike photos, events and adverts are time sensitive and expired. Advertisement functionality had never displayed the same popularity as the photo galleries, and we had quickly come to recognise the importance of timeliness in display content. The presence of content on the display up to this point had acted to encourage use by others and signify [22] appropriate content; thus having the display regularly showing no content appeared to discourage subsequent usage.

In revisiting this deployment, we interviewed our champion, who had been responsible for encouraging other residents to use the display and also generated a considerable amount of content herself, including large batches of photos and manually importing event listings from the village's existing paper newsletter. Although both displays were still in use, she confirmed that enthusiasm for the display had waned following the conclusion of the project: "it needs a new buzz now [...] it's just another thing that's there". As potential solutions to this issue, she expressed interest in new students working with the system, or having the ability to modify the display herself to introduce new features and keep it exciting to residents.

Discussion

The issues described above cover both *technology* and *usage* categories, but both are essentially underpinned by *resource* issues. Although the core problem with the failed display was technical, it was unavailability of funding and staff from the university and the lack of technical confidence in the village and that made this difficult to correct. During the lifetime of the project it would have been a simple matter to reinstall the display software or replace broken hardware. This raises questions around funding models for research in the wild, which may need to more explicitly address these problems and provide more lightweight means of funding small, ongoing activities relating to research projects.

Many of the technical issues could have been eased through a number of small steps, such as providing the software and instructions in advance. However, this would not create the necessary technical skills or confidence that were lacking in this case. More apparent is the need to create these skills if technologies are to be adopted and used in the long term, so that the community is able to carry out these tasks themselves, or perhaps even continue to develop the technology on their own. There was some enthusiasm for this approach from our champion.

Of more concern were the usage issues that coincided with the end of research activities in the village. Although we have not been given cause to question our earlier results, it could be that the energy being invested in the project encouraged use of the display, despite researchers not taking any steps to do so. Brown *et al.* [2] identified demand characteristics as an influencing factor in fieldwork: users may shape their behaviours when being studied, perhaps aiming to be 'good' participants and helping researchers achieve the results they desire. This is not necessarily a conscious effect: others have noted that participants in field trials have "better things to do" [24] than play up to researchers' expectations.

Despite the overall success of the handover, there was clearly an issue around the sustainability of the display's content, inviting us to consider how we can design for content generation over long periods of time. Certainly the

reliance on one key participant runs the risk of this individual ‘burning out’ [23], leading to the collapse of the system. While it is certainly preferable to have content that is generated by community members, there may be alternatives when user-generated content is in short supply. For example, technologies might draw upon known sources of information, such as RSS feeds or social networking sites that already have a critical mass of users and are unlikely to suffer from a dearth of content.

CASE STUDY 2: THE BESPOKE PROJECT

The Bespoke project ran from 2009 to 2011, aiming to explore the use of citizen journalism to design unique technologies for a specific community. We worked with the Callon and Fishwick communities in Preston, North West England, designing technologies that addressed digital exclusion, not by forcing existing technologies onto users, but by designing bespoke solutions that met their individual needs. This ultimately led to a number of technologies being deployed in the wild in a variety of settings, including public spaces, private homes, schools and with community organisations. Here, we will focus on two technologies: Viewpoint, a public voting device, and Wayfinder, a digital signpost.

Viewpoint [30] was designed in response to expressions of disillusionment from members of the community, who had been frequently consulted on improvements to their area but rarely perceived any benefit from their participation. To address this problem, Viewpoint attempted to make participating in local decision-making as simple as possible, by allowing local politicians and community organisations to post binary questions that appeared on devices in public locations. Residents could vote using two large buttons on the front of the device (Figure 2), or by text message. To create a sense of efficacy, the device also required that a response be posted for each question, showing how the community’s input would be used. This was implemented using an open-frame monitor and a compact PC inside custom housing, with a hacked mouse providing button functionality. Viewpoint devices were installed in a local shop, a community centre and the offices of a local housing association for a period of two months, during which time questions were posted weekly.

Another theme that emerged in our work with the community was lack of awareness of activities being carried out by local groups. Wayfinder was developed as a novel form of noticeboard, which was capable of receiving SMS messages containing a description and location of an event. This would be displayed on Wayfinder’s LED display (Figure 3) and an arrow on top of the device would rotate to point in the direction of the event. This was implemented using an Arduino board to receive messages and control the arrow motor, with a commercial LED sign in a customised housing to display messages. Wayfinders were deployed outside a church and a housing association office, while a third was deployed inside a community



Figure 2. Viewpoint deployed in a local shop.



Figure 3. Wayfinder installed on a community housing office.

centre. Like Viewpoint, this was deployed initially for a two-month period. As a form of moderation, representatives from each of the venues were given instructions on how to message the devices, which they were asked to distribute to groups and individuals that they trusted to post content.

Handover Process

A core aspect of Bespoke’s ethos was the importance of having a lasting effect on the community. The area was already suffering from ‘consultation fatigue’, caused by frequent consultations on improving the area with little perceived effect, so we did not want to contribute to this issue by simply leaving at the end of the project. Instead, it was intended that the project should have a legacy beyond its conclusion and that the technologies developed would have a meaningful impact on the community in the long term. However, when each of the venues hosting one of the deployments were given the option to retain the deployments, one of the Wayfinder hosts and two of the Viewpoint hosts asked for the devices to be removed. Reasons for this included them taking up too much space and not being seen as valuable additions to the venues.

For the remaining devices, a number of alterations needed to be made due to reliance on third-party services. Both Viewpoint and Wayfinder relied on an SMS messaging service to provide mobile interaction, which allowed users to vote on Viewpoint or send messages to Wayfinder using an easy five-digit short code rather than a full-length telephone number. This service also was used to multiplex a single message to all three Wayfinders and rotate through multiple messages on a schedule. This was a subscription service paid for from project funds and it was not felt that the community would be willing to take on this cost.

We planned a graceful degradation of functionality to remove reliance on this service. In the case of Viewpoint, text messaging voting had not proven popular, which justified removing the text message functionality altogether. In the case of Wayfinder, we simply provided device hosts with the long-form telephone number for their individual device. This allowed messages to be sent directly to their Wayfinder for immediate display, but not to be scheduled or shared across multiple Wayfinders.

There was a strong desire from the hosts of both Wayfinders to be able to schedule messages through a web interface rather than by mobile phone. However, as the devices were built on embedded hardware rather than an enclosed PC, we had limited ability to make alterations. It was not possible to add Internet connectivity with the time and other resources available at the end of the project.

Legacy

Despite the team's best intentions, neither Viewpoint nor Wayfinder saw continued use by the community after the end of the project. No new polls were posted on Viewpoint and only a small number of messages were posted on Wayfinder. Due to the nature of the technologies, this was particularly problematic: both designs relied on a regular influx of new content to make them viable. Furthermore, neither had time-insensitive material, such as photos, to compensate for lack of contemporaneous content. Wayfinder in particular existed very much 'in the moment', showing current and upcoming events rather than an archive of past material. Consequently, it was critical that sustainable usage emerged if the technologies were to be handed over to the community.

These problems began to emerge even during the trial period. For example, it had been necessary for a member of the research team to put considerable effort into sourcing questions for Viewpoint. Our intention was that this trial period would be an opportunity for partner organisations in the community to become comfortable with the technology, after which they would be confident to make use of it on their own without input from the project team. However, this usage did not emerge over the eight-week trial. There were additional problems with sending messages to Wayfinder by text message, which users found too complicated.

There were also technical issues with Wayfinder—which stopped responding to text message input—that were difficult to support. The Bespoke project was a joint venture between five geographically dispersed institutions, with the technical teams located remotely from the field site, meaning it was more difficult to make trips to the community to make small repairs or alterations. Again, the customised hardware used to build Wayfinder made it impossible for a novice user to debug even with instructions. This led to expressions of irritation from at least one of the device hosts. As was the case in Wray, project staff naturally also became less available once the project had been completed.

As a result, all of the Viewpoint and Wayfinder deployments were removed from the community within six months of the project's conclusion. However, despite the difficulties in handing over these two technologies, the project was not without successes. One of the other designs, the Family Hedge [31], remains in use in a local school. Furthermore, groups and participants involved in the Bespoke project have gone on to be involved in subsequent projects with members of the research team. In particular, elements of the journalism process put in place to inform the design process have continued to operate in the community and have proven to be more sustainable as an intervention than the designs themselves.

Discussion

In contrast to Wray, where most problems occurred after handover had been completed, the majority of problems in the Bespoke project occurred during the handover process. In this case, there was a complex mix of technical, usage and resource issues in play: the deployments had not developed sustainable patterns of usage prior to handover, partly due to the technical problems that had occurred during the deployments, which made it difficult for the community to make best use of them. Lack of resources, in terms of development time and availability of researchers, were at least partly responsible for these issues and the difficulties in solving them.

Perhaps most problematic was the lack of time to iterate over the designs after their initial deployment. This is most clearly manifested in Wayfinder, where users clearly expressed a desire for different functionality that could not be provided within the project's timeframe. In part, the inability to provide these features, which would have made the device easier to use, contributed towards its failure. Iteration is, of course, a key feature of action research, allowing knowledge to be gained over time and fed into new designs and solutions. Although our understanding of the community had evolved over a number of design phases, each of the individual designs was relatively static once deployed.

Experiences on the Bespoke project also clearly demonstrate the need for usage of a deployment to become

self-sustaining *before* the end of the project and any attempt at handover. As this was a shorter project with greater time constraints, there was no meaningful buy-in from members of the community. Instead, the technologies were seen as short-term trials that were not integrated into the community's routines. Far from being a benefit for the community, a technology that is difficult to support while not being perceived to offer and value can instead be a burden.

LEAVING THE WILD

In the case studies above, we have highlighted a variety of issues that can arise as researchers attempt to design technology in the wild and attempt to hand over the results to participants. These issues relate to technical issues, to issues with sustainable usage and ultimately to the lack of resources available for these activities. While this is not a comprehensive survey of the problems that might be encountered, we can draw from these experiences several distinct categories of problems and steps that can be taken during earlier stages of the project to avoid them. In the following sections, we offer a generic model for approaching technology handovers based on our experiences.

Expectation Management

The first step that can be taken when approaching a community is managing expectations. This involves making clear to participants that research prototypes may not be as stable as commercial technologies, particularly if using an iterative approach where early versions may be somewhat experimental. It also involves making clear whether the community can expect to keep the technology at the project's end. This is also an appropriate time to begin the discussion about what happens at the end of the project. By making this clear at the very beginning, it allows prior planning for handover and may also help participants to decide on how much time and effort they are willing to commit to the project, which might be larger or smaller depending on whether they expect to keep the technology or not.

It may seem pragmatic to keep expectations low while keeping an open mind on handovers, such that any subsequent handover is seen as a 'bonus'. However, we suspect this could potentially make it more difficult for deployments to be accepted as permanent fixtures. We see particular value in encouraging a community to feel a sense of ownership of the deployments and not to treat them as field trials owned by the researchers. We believe that this is a key part of sustainably integrating technologies into community life.

In some cases, it may be that circumstances change over the duration of the project. Not all technologies successfully take hold and may be rejected by participants, while in other cases it may become possible to hand over a technology that was not originally intended to be deployed

permanently. We will discuss this as a distinct stage to be considered later in the process.

Tensions Around Experimental Technology

One of the core causes of the issues we have described is the nature of research prototypes. While each of the technologies we deployed was reasonably stable, research prototypes are rarely as robust as commercial products. Even the most robust still lack the long-term support and planned product life cycle that users may be accustomed to. This is a difficult problem to overcome with the resources available to research projects. Our solution has often been to utilise off-the-shelf components as much as possible, which have themselves gone through a more rigorous development process and can be more easily replaced should they suffer a failure. This also increases the availability of technical expertise in the communities. For example, participants are more likely to be able to perform maintenance on Windows PCs than Arduino boards.

There is a delicate balance to be found between utilising all the resources available to us as researchers, while ensuring that these resources do not become a cornerstone that, when taken away, causes the technology to collapse. In many cases, this may conflict with our research objectives. For example, exploring Bluetooth as an interaction method was one of the early goals of the Wray Photo Display, but lack of reliability and familiarity with this technology led it to be troublesome and was ultimately removed in the interest of robustness. In the Bespoke project, Wayfinder was more troublesome than Viewpoint due to its ambitious design—being based on custom hardware and located outdoors, where the other two deployments discussed have broadly been based on normal computer hardware. One potential solution to this problem might be to provide mainstream technologies that replicate the core features of the prototypes. For example, the Wray backup tool would have allowed content to be uploaded to a mainstream photo service and potentially still be shown on a public display (e.g. as a slideshow).

Iterative Development

One of the primary differences between our two case studies was the ability to iteratively develop prototypes. In Wray, we were able to spend several years improving the displays based on feedback from the community. As the deployment was only a display with no customised elements, we had great flexibility in the interface and even the services provided. The Bespoke project was more time-constrained, and while we were able to iterate over the early design of the technology with input from residents, there was no opportunity to make significant changes to the devices after they had been built and deployed, particularly given the very customised nature of the hardware cases.

Based on this experience, we would strongly recommend iterative development of technologies that are intended for long-term, sustainable use. In doing this, we can increase

the likelihood of designing technologies that will take hold in the community, creating the patterns of usage embedded in day-to-day life that will allow use of the technology to become sustainable over time. This also provides greater opportunities for members of the community to have input in the design process and develop a sense of ownership of the technology.

Creating Skills

A further major contributor to the issues surrounding technology handovers has been the lack of skills available to maintain prototypes or to continue development once researchers have departed. Although researchers continued to invest time in both our case studies after projects had ended, there is clearly a limit on the extent to which this can reasonably be provided, in terms of both time and funding available.

One solution posed by Merkel *et al.* [20] is to ensure that the process of developing technologies imbues in participants the skills necessary to maintain and develop technologies themselves. In their work, the researchers did not develop technologies themselves, but simply acted as facilitators in the development process and attempted to increase the community's problem-solving capacity. However, these projects were largely based around the development of websites and other simple applications. It is less clear how this might apply to novel pervasive technologies, which can be more complicated or difficult to develop and maintain. In these cases, the research goal is often the development of a technology that the participants do not have the capacity to build themselves. In discussing this same problem in relation to action research, Hayes [12] suggested utilising enthusiastic participants who could provide a basic level of support and act as a contact point for others in the community.

We would suggest that a combination of both these approaches would be most effective. Having a 'champion' in Wray was invaluable at all stages of the project and provided us with a point of contact in the community after the end of the project who could perform basic maintenance and work with us using, for example, remote desktop sessions. The lack of such an individual certainly contributed to difficulties experienced with the Bespoke deployments, as there was no person in the community who was actively championing and encouraging use of technologies. We would suggest that this contact is often an ideal person to spearhead the development of skills in the community. Even if this person does not have the required skills themselves, their enthusiasm can still drive other members of the community to become more involved. This is a process that should take place throughout the entire project, however, and not just at the point of handover. Often it has been a case of building confidence as well as skills, which can take considerable time and experience with the technology.

Reaching a Mutual Agreement

In both of the projects we have discussed, it was fully intended that the technologies developed would be handed over to the community when research concluded. In Wray, this was seen as a means of guaranteeing to residents that their participation was not in vain, while the Bespoke project actively aimed to leave a legacy that would provide ongoing value to the community. However, as we discussed above, there may be circumstances in which this is not the most appropriate course of action at the project's conclusion, particularly when circumstances and expectations have changed throughout the project's lifetime.

As was the case with Bespoke, communities might not always wish to keep developed technologies at the end of the project, particularly when sustainable levels of use have not emerged. Indeed, it was made clear to device hosts that no long-term commitment was required. It is important to have an honest discussion with communities and particularly with the hosts of technologies. This can be difficult, as researchers may be strongly in favour of one option and users may be hesitant about seeming to reject their work. Gaver *et al.* [10] defined a number of indicators of successful engagement with a technology that could be useful in making this decision, including enthusiastic discussion, persistent use and enthusiasm towards owning the device.

In our experience, the length of the deployment is one of the larger contributing factors in the probability of a technology being adopted and truly becoming useful to the community. WrayDisplay had been in the village for around four years when the project ended, giving the community a considerable amount of time to integrate it into their communicative ecology and foster a sense of ownership, as well as time for iterative development.

Planning for Handovers

In both projects, better planning of the handover itself could have mitigated problems that arose. As seems common amongst similar projects, work plans either did not allocate time for this activity or the closing stages of a project had to be compressed due to time constraints. In terms of research outputs, this phase of the project is one of the least important, but where sustainable benefit for the community is desired, it is vital.

In addition to ensuring that time and funding is set aside for this phase of the project, it is also important to clearly plan responsibilities and make sure that as much relevant information as possible is given to the community. For example, who will be responsible for administration and maintenance and for how long? Who can be contacted in the event of problems? When attempting to repair WrayDisplay, one source of delay was uncertainty over to what extent the university remained responsible for the deployment and how much support could be provided.

Again, it was tempting to make a vague promise that it *might* be possible to continue development, but this leaves neither party with a clear understanding of who is ultimately responsible. In our experience, this clarity would have been of great benefit.

Evaluating Success

One remaining question is how we define a ‘successful’ community handover, which will influence how we plan for the end of a project. Most obviously, this will include cases where the technology developed throughout the lifetime of the project continues to be used in the way that the designers intended. However, it might also include cases where the community appropriates a technology for different purposes or finds their own way of supporting the practices emerging from the prototype. This is particularly true in cases where the technology was intended to act as a probe to expose needs and demonstrate potential uses of new technologies.

By these criteria, we would consider WrayDisplay to be a successful handover, in the sense that it continued to be used, although the arrangements around support for the deployment proved to be less than ideal. Furthermore, it acted to promote new content sharing behaviours in the village that have continued beyond the project, albeit at reduced levels. As a technology handover, it is clear that the Bespoke prototypes were not successful. However, as we have discussed, other aspects of the project, including the citizen journalism platform and the relationship with the community, continue to bring sustainable value to the area.

Ongoing Relationships

Throughout this paper, we have largely taken the view that the end of a project marks the end of research activities with a community. This can be a useful assumption to make when planning projects, as it encourages more consideration of the issues we have described, but is not always the case. For many community projects—as was the case in both Wray and Preston—the established relationship may be continued into new projects. As we have discussed previously, this can be a powerful motivator for all parties to continue contributing effort to maintaining the deployments even after the end of the project. If subsequent work in the community relies on previous deployments, as was the case with WrayDisplay relying on the village network, then this provides even further motivation.

Although there is certainly a case to be made for conducting research in a broader range of environments, these ongoing relationships also allow us to build a much deeper understanding of the community and their particular design requirements. This is one of the main benefits of working with communities in the wild over long periods.

SUMMARY

In hindsight, it is clear that there were many ways in which both of our case studies could have better dealt with the

handover of prototype technologies to the community. In light of this, the intention of this paper is to underscore the need for greater exploration of how technologies can be handed over to the participants and supported. If this can be achieved, there is great potential for technologies developed as part of research activities in communities to have a meaningful impact, not just during the lifetime of the project, but for many years afterwards.

We stress that the steps we have highlighted above do not just take place during the final stages of a project, but throughout the duration of our engagement with the community. Expectation management, skill building and robustness are considerations that must have bearing on our decision-making throughout the development and deployment of prototypes. In our experience, attempting to consider these factors only at the end of the project has led to disappointing results.

Finally, we also emphasise the call for longer-term engagement with communities as a means of supporting the sustainability of technologies. In this way, we can support mutually beneficial relationships between research establishments and the general public and ensure that our research has an ongoing impact in the community.

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